

Moving Toward MRV

**Structures Enhancing International Recognition
of
Advanced Greenhouse Gas Measurement Capabilities**



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Outline

- **Quality in Greenhouse Gas Quantification**
- **Future GHG Quantification Needs and Measurement Challenges**
- **Future Observing Capabilities**
- **International Testbeds**
 - **Facilitation Opportunities via the Metré Convention**
 - **A Framework Proposal**
 - **Efforts to Move Toward a Testbed Framework**

Recognition of Measurement Results

Desired Quality of Greenhouse Gas Inventory Data

- Quantification Supporting Market / Regulatory Functions
 - Best Case: Material quantities & *their variation* are known and agreed & not a point of contention
- International Trade as Paradigm
 - Quantification technologies commonly used & accepted in trade are well established & routinely unquestioned
 - Mass and Volume measurement have been a staple in trade for millennia
 - Confidence in the material quantities in commercial transactions is foundational to harmony in commerce



Desired GHG Quantification to Implement
Trade or Regulation Approaches

CO_{2e} ton Emitted \cong CO_{2e} ton Removed

CO_{2e} ton (urban) \cong CO_{2e} ton (biogenic)

Future Greenhouse Gas Measurements Accuracy Needs

U.S. Reduction Targets

- Inventory data are performance metrics for national and international reduction efforts
- Pres. Obama's Climate Action Plan: 17 % relative to 2005 by 2020
- EPA carbon rule (Electrical Gen.): ~30 % relative to 2012 by 2030

Gauging Progress / Target Achievement

- Accuracy requirements at the 1% - 5% Level
- Based on internationally-recognized measurement methodologies

Greenhouse Gas Inventory Data Needs Assessment

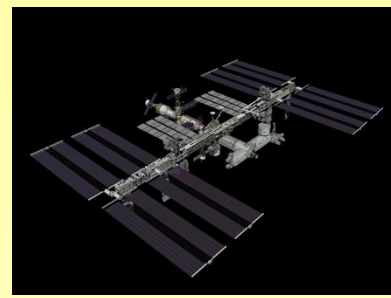
- Confidence reduction *target achievement and progress monitoring* is enhanced by increased quantification reliability and accuracy
- Advances in a range of measurement capabilities are needed to *assess progress toward and attainment of* reduction targets
 - Both bottom-up and top-down

Actionable Information

- Attribution (Identity) of emitter/absorbers support both regulatory and market needs
- Requires measurement capabilities at relatively small geospatial scales

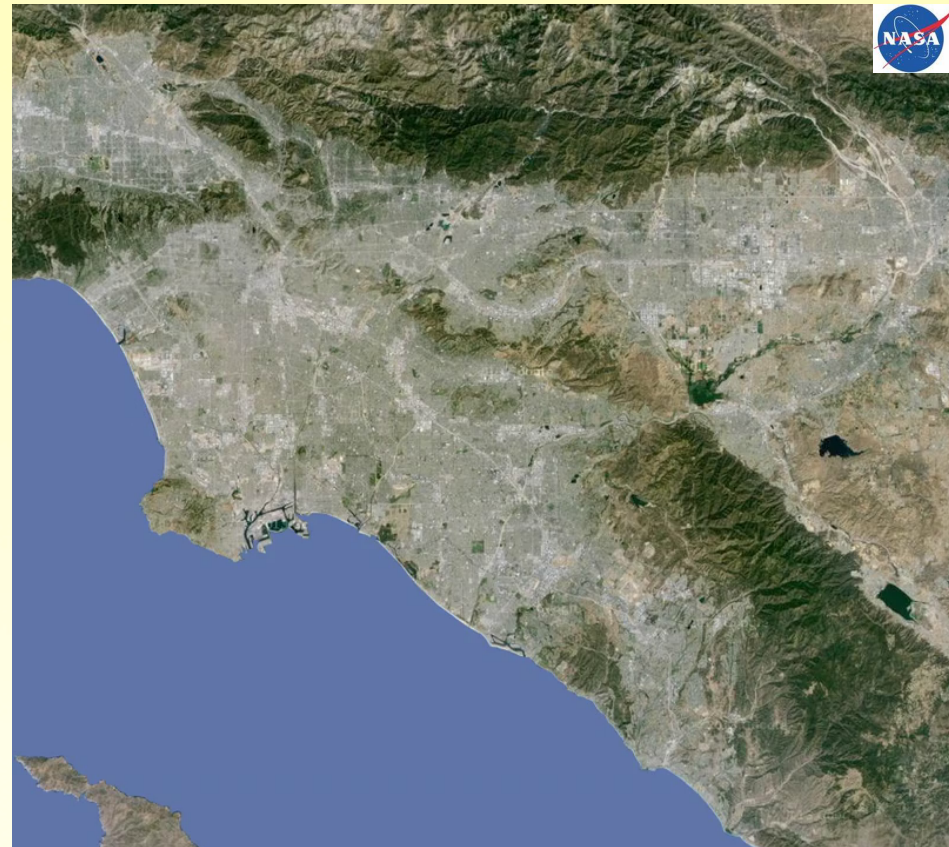
Future Observing & Measurement Capabilities

OCO 3 - International Space Station



Broadly Mapping of a City's CO₂ Footprint

- A space-based instrument designed to investigate important questions about CO₂ distribution on Earth applicable to growing urban populations and changing patterns of fossil fuel use
- Future deployment on the International Space Station (launch status: TBD).
- Continue the OCO-2 CO₂ data record for carbon cycle science with an additional capability enabled by a more flexible pointing system: Regular sampling of more world cities and power plants (over 80% of fossil-fuel CO₂ emission sources monthly) than available with OCO-2.
- ~4,000 – 1 x 3 km footprints per sampling pass

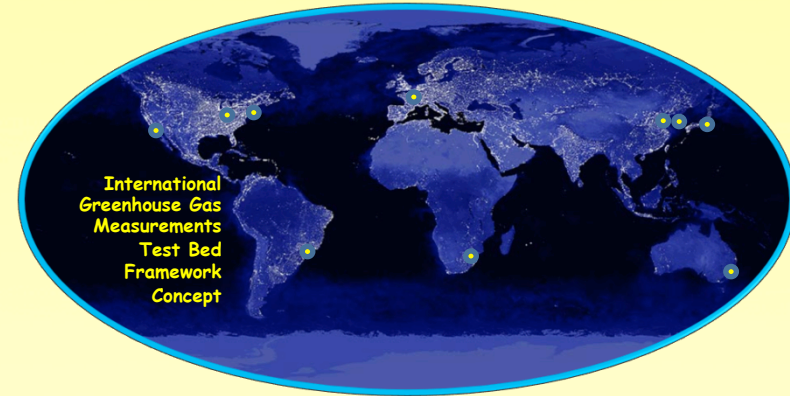


International GHG Measurements Framework

Engaging the Metrology & Climate Communities

Concept:

- An International Greenhouse Gas Measurements Test Bed Framework that:
 - Enables joint development of advanced measurement capabilities for urban and regional GHG domes and their dynamics,
 - Establishes scientific validity and performance capabilities of advanced measurement methodologies and instruments,
 - Provides a focus for multi-organization efforts with locations and organization on all continents but Antarctica,
 - Facilitates open, internationally-recognized measurement methodology development and evaluation with open data exchange and utilization across national borders, and
 - Strengthens methods to correlate and calibrate satellite instrument observations on-orbit with those made on the surface as a means to advance accuracy and establish SI traceability

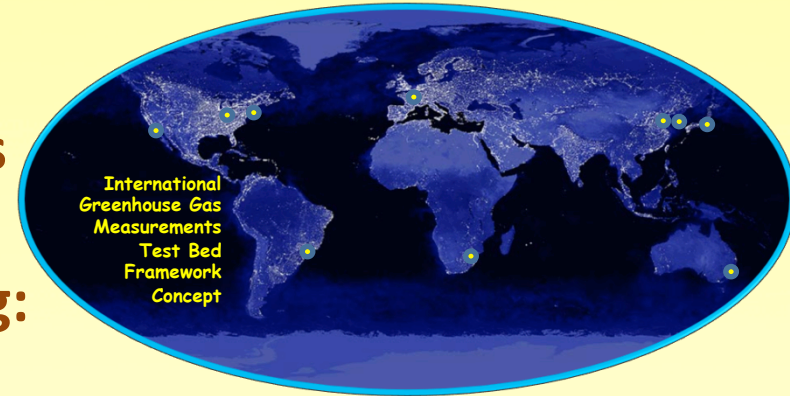


International GHG Measurements Framework

Engaging the Metrology & Climate Communities

Approach:

- **Focus on Megacities as test bed sites**
 - Cover 6 of the 7 continents
- **Engage with nations / regions having:**
 - Suitably located megacities
 - The scientific and technological capabilities needed, and
 - The necessary national interest and will to commit the required resources
- **Use existing structures available within the Mètre Convention**
 - Operational, internationally-recognized treaty organization with well-demonstrated working relationships and organizational structures
 - Facilitates communication & dialog
 - Broaden international linkages – WMO, international climate change/science communities



Status:

- **Projects underway Paris and the U.S.; Planned in Brazil**

Developing Tools & Test Beds for Diagnosing Inventory Accuracy for U. S. Urban GHG Domes

Assessing Performance of Greenhouse Gas Measurement Tools at Urban Scales

The Indianapolis Flux Experiment (INFLUX)

- *A Top-Down/Bottom-Up Greenhouse Gas Quantification Experiment in the City of Indianapolis, Indiana*

The LA Megacity Carbon Project

- *Estimating the Emissions Trends in a Megacity Having Complex Topography & Meteorology*

The Northeast Corridor Project

- *The Largest U.S. Megacity*
- *A Test Bed Having Moderately Complex Topography & Meteorology*
- *Initiation of The Effort Began in Mid-FY 14.*

A U.S. Step Towards an International Urban Greenhouse Gas Measurements Testbed Framework Useful for Measuring Instrument Calibration & Performance Assessment – Satellite and Surface-Based

International Recognition of Measurement Results

Enhancing Quality of GHG Inventory Data

- Quantification Supporting Market / Regulatory Functions
 - Best Case: Material quantities & *their variation* are known and agreed & not a point of contention
- A Measurements Framework Supporting Economic Systems
The Metré Convention (1875)
 - Governance Orgs.: General Conference on Weights and Measures & International Committee on Weights and Measures (CIPM)
 - Implementing Org.: International Bureau of Weights and Measures
 - Activity Focus: Ensure comparability and recognition of national measurement standards,
hence measurement results across borders & time
 - Framework: The CIPM Mutual Recognition Arrangement
(<http://www.bipm.org/en/cipm-mra/>)
 - Member State Rep: National Metrology Institutions
 - NIST: U.S. National Metrology Institute
Responsibilities for accurate quantification & quality measures and their supporting methods & standards

Within and Between Community Agreements and Outreach

Metré Convention & CIPM Mutual Recognition Arrangement

- 53 member states & 41 States Associated with the CGPM
- International Organizations
 - World Meteorological Org., European Space Agency, Inst. For Ref. Materials & Measurements, International Atomic Energy Agency

Joint Meetings / Workshops

- WMO-BIPM Workshop on Measurement Challenges for Global Observation Systems for Climate Change Monitoring: Traceability, Stability and Uncertainty – April 2010
- Workshop Series in the Americas
 - Organization of American States/U.S. Mission to the OAS/NIST : Metrology and Technology Challenges of Climate Science and Renewable Energy Central Am. South Am., and Andean Countries regional workshops – 2014; Caribbean Region 2015
- U.S.-China Bilateral workshops on Metrology Challenges in Climate Science – 2011 thru 2014

THANK YOU FOR YOUR
ATTENTION